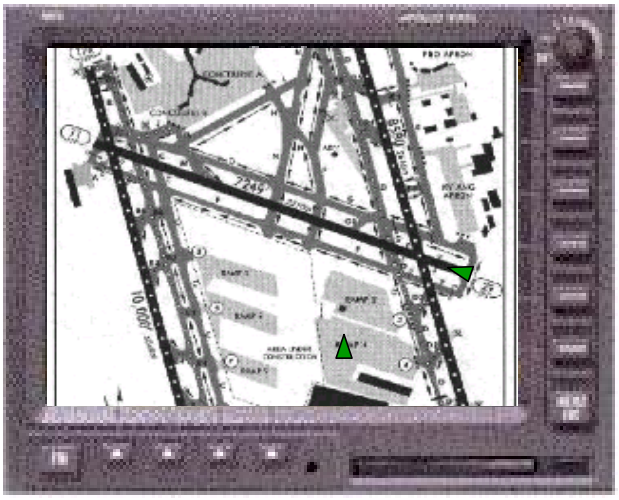
AD-7: Enhance Surface Situational Awareness

Improve surface navigation and traffic situational awareness with cockpit-based tools.

Final Approach, Runway and Taxiway Occupancy Awareness



Background

In today's environment, the pilot uses visual navigation aids and air traffic controller communications to determine aircraft position on the airport surface and uses visual references to maintain separation from aircraft and other vehicles. While the air traffic controller is responsible for separation on the runway, the pilot is responsible for separation while taxiing to the runway or gate, regardless of airport visibility. Low visibility and reduced ability to see signage can lead to confusion in navigating the aircraft on the surface. This in turn can result in the reduction of safety and efficiency through reductions in taxi times and increased fuel burn.

Cockpit simulation studies performed by NASA over a period of years, documented significant reductions in taxi times of 25% to 19% during periods of low/moderate visibility when pilots used cockpit Surface Moving Map (SMM) displays as an aid. These findings were corroborated by flight tests conducted by the Safe Flight-21 (SF-21) program at Louisville, KY, in October 2000. Future use of this capability is dependent on two key pacing events:

- First, the government, acting as an enabler, must continue to mature this technology to ensure its viability. Maturation on the government's part involves a range of activities, including development of the technology and the procedures to enable its use. A key enabler will be Broadcast Services, which will allow the pilot to view all traffic in the surface environment via an uplink of traffic data from FAA fielded Multilateration systems. At this time, through the collaborative Government/Industry partnership established in the SF-21 program, a range of developmental activities is being completed.

- Second, airlines must equip their aircraft fleets with moving map capability and have the equipment installation certified by the FAA. The cost of equipage, is typically born by the airline industry, and the level of equipage achieved will be the pacing item toward realizing the full anticipated benefits for this application.

Surface Movement Guidance and Control System (SMGCS) is required to support low visibility operations on the surface. According to Advisory Circular 120-57A, SMGCS is meant to facilitate "safe movement of aircraft and vehicles on the airport by establishing rigorous control procedures and requiring enhanced visual aids." SMGCS is tailored to each airport's specific needs and may include taxiway edge lights, taxiway centerline lights, runway guard lights, stopbar lights, taxiway/ramp marking, follow-me vehicles, training, and charting, among other initiatives. SMGCS has two categories for takeoff and landing operations: below 1,200 feet Runway Visual Range (RVR) and below 600 RVR (but not less than 300 RVR).

Ops Change Description

Air Traffic Control (ATC)

The cockpit SMM tools would now give the pilot the electronic ability to "virtually" see the same "Big Picture" view that ATC is seeing. The efficiency of ATC communications would be greatly amplified by allowing ATC to positively identify specific traffic or traffic sequences to the aircrew, which should help in the execution of taxi plans. A "Call Sign Procedure" will enable ATC to communicate the appropriate aircraft specific information.

Cockpit

Cockpit SMM tools provide crews more robust surface navigation information, increasing pilot awareness of the aircraft's position on the airport surface and other traffic operating in proximity to the aircraft. These tools help the pilot guide aircraft along the surface in accordance with ATC instructions, or in accordance with a self-generated taxi plan in the case of non-towered airports. Initially, these tools will supplement the pilot's out-the-window visual assessment of the aircraft's position on the surface, its direction, and speed. The increased knowledge of exact aircraft placement relative to the airport has been demonstrated to decrease crew workload and improve taxi performance.

In today's environment, taxi workload is normally divided between Pilot Flying (PF) and Pilot Not Flying (PNF). PF typically steers the aircraft using visual techniques. The PNF typically backs up the pilot by monitoring progressive taxi with paper maps, and handles communication with ATC. Cockpit procedural changes will allow both crewmembers to make use of the display to monitor progressive taxi, and to use the displays to positively identify specific aircraft that they may be directed to follow by ATC in a taxi sequence. Additionally, crews will need to adjust to new "Call Sign Procedures" to enable the positive identification of aircraft between ATC and the crew. This change will place the aircraft's three-letter designator onto the display.

Knowledge of proximal traffic along with call sign information is extremely useful to enable crews to correlate traffic observed on the display with outside visual information, thereby easing the process of understanding the intended sequencing when several aircraft are being formed into a

queue. When crews understand the "big picture" of traffic sequencing it is expected to enable better tactical decision-making. This in turn will allow crews to take measures, such as temporary shutdown of engines to save fuel.

Benefits, Performance and Metrics

- Faster taxi times at night and under other reduced visibility conditions.
- Average and excess gate times should decrease.
- Reduced fuel burn during taxi
- As calculated in the Safe Flight-21 Cost Benefit Analysis, date 01 May 01, it is anticipated that reduced taxi times could result in approximately $3.241B in cost savings over a 20 year life cycle.

Scope and Applicability

In today's environment, ATC formulates overall taxi sequence plans, and communicates these plans as a set of instructions to both aircraft and vehicles through radio communications. The biggest challenge for ATC is making sure that the aircraft understands the communications. In executing the taxi plan, ATC uses many techniques such as identification of "company traffic" or other descriptors to ensure that pilots understand their place in the "big picture".

Moving maps should provide the same capability to receive and display the same surveillance data to tower controllers, pilots, ramp controllers, and others that are involved with surface operations. These maps are proposed for 59 ASDE-X sites.

- FAA Surface Moving Map (SMM) Enabling Activities:
    - FAA-approved Concept of Operation – March 2002
    - FAA to complete all Key Site activities at Louisville/Sandiford Airport (SDF), including Surface Operational Safety Assessment – November 2002 and the in-service evaluation and metrics collection there – Sep 2001- Sep 2005
    - Call-sign procedure limited implementation at Memphis Airport and SDF– September 2002
    - Deliver airport surface map database for top 65 airports – February 2003

[1] *Surface Technology Roadmap, Presentation to Runway Incursion Joint Safety Implementation Team (JSIT)*, presented by David Ford (AND-500), March 7, 2001.
[2] Automatic conflict alerts in the cockpit are not included, but the issues (human factors, training, certification) will be addressed as part of ongoing research activities.

- Airline Certification and Installation Plans:
    - United Parcel Service (UPS) Supplemental Type Certification **(**STC) for SMM in Boeing 757 – October 2002

Benefits measurements have, to date, only been simulated. It is anticipated that equipage of the UPS fleet with SMM's at their SDF Hub facility will provide the first opportunity to measure actual performance improvements. If the bottleneck is at the departure end of the runway, increased throughput on the surface will not result in significant capacity benefits.

Key Decisions

- Crew coordination changes will be needed to make the most of new SMM information in the cockpit.
- Until very advanced operations are approved, the surface applications should be in support of the visual maneuvering of the aircraft and should only be used in an advisory role.
- SF-21 is currently anticipating UPS to commit to installing SMM's starting with their 757 fleet, beginning in October 2002.
- Beyond UPS, all airlines will have to commit to equipping their fleet with SMM's.

Key Risks

- Operations fall back to the current mode when position sensors (e.g., GPS-based signal) are not providing adequate accuracy or integrity (depending on the complexity of surface application) or if there is a problem with onboard avionics.
- Failure on the part of UPS airline to start equipping it's fleet with SMM's, will significantly impact our ability to implement this capability or measure anticipated benefits.
- Contingent on continued funding, SF-21 must continue maturing the technology and deliver several critical items including:
    - Resolution of cockpit human factors/workload issues (heads-down time, surface clutter, day/night visibility, and display scale, heads up/down)
    - Development of "Call Sign" Procedure for initial use at SDF
    - Development of Map Data Base for top 60 airports
    - Operational Safety Assessment to support certification
- Managing change in the acceptance of new procedures based on new technologies, from both the ATC and aircraft operators' perspectives.
- Feasibility of procedures in mixed equipage environment.

- Beyond the initial applicant, expanding use SMM to enable this application at other airports.